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Multi-angle Imaging SpectroRadiometer (MISR)

AirMISR Data Products Specifications

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To determine the latest released version of this document, consult the MISR web site (http://www-misr.jpl.nasa.gov).

JPL

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Document Change Log

Revision	Date	Affected Portions and Description
	4 December 2000	All, original release

TBD List

Location	Description

Table of Contents

List of Tables

Acronym List

AirMISR	Airborne Multiangle Imaging SpectroRadiometer
API	Application Interface
DAAC	Distributed Active Archive Center
ECS	EOS Core System
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
HDF	Hierarchical Data Format
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
MISR	Multiangle Imaging SpectroRadiometer
NASA	National Aeronautics and Space Administration
NCSA	National Center for Supercomputing Applications
SCF	Science Computing Facility
SDP	Science Data Processing
UTM	Universal Transverse Mercator

1.0 INTRODUCTION

1.1 IDENTIFICATION

This document describes the data products produced by the Airborne Multiangle Imaging SpectroRadiometer (AirMISR) sensor. The AirMISR instrument was developed to perform validation studies for the MISR project. MISR is a component of the Earth Observing System (EOS) Terra Mission, and the EOS Data Information System (EOSDIS), which in themselves are components of the National Aeronautics and Space Administration's (NASA) Earth Science Enterprise.

1.2 OVERVIEW

AirMISR Science Data Processing (SDP) exists to produce science and supporting data products from AirMISR instrument data. This document describes the data products which are delivered to the Atmospheric Sciences Data Center (ASDC) at NASA's Langley Research Center (LaRC).

The MISR Science Computing Facility (SCF) will support the development of AirMISR science algorithms and software, instrument calibration and performance assessment, as well as provide quality assessment and data validation services with respect to AirMISR SDP. This will include production of data and coefficients required to produce AirMISR data products at the SCF.

1.3 DOCUMENT SCOPE

This document describes the AirMISR SDP Level 1 deliverable data products. It describes in detail each of the AirMISR product files. This document is not meant to be the definitive description of the external input files that are products of other data processing systems. It will only describe the elements that AirMISR needs for its processing, in sufficient detail for AirMISR purposes.

Section 1 of this document is the Introduction to the document.

Section 2 describes the interfaces which this document covers.

Section 3 gives descriptive information common to all of the files described in this document. It describes the overall structure of the native HDF and HDF-EOS grid files.

Section 4 covers the Level 1B1 Radiometric Product.

Section 5 covers the Level 1B2 Georectified Radiance Product.

1.4 METHOD

The method employed in describing these interfaces is to detail the file structure, giving the general layout of the file schematically, describing the contents of the metadata included and describing the grid structures as needed.

1.5 NOTATION

Different types of notation are used for the sections that make up this document:

1) Grid metadata and the various types of AirMISR-specific metadata (such as file and per-block metadata) are listed in tables.

1.6 CONTROLLING DOCUMENTS

1) MISR Science Data Processing Functional Requirements Document, (FRD) JPL D-12417, September 1996 (or latest version).
2) MISR Experiment Implementation Plan, Volume III, Science, Data Processing, and Instrument Operations, Technical and Management Plan (EIP), JPL D-11520, 24 January 1996 (or latest version).
3) MISR Science Data System Software Management Plan (SMP), JPL D-11641, February 1996 (or latest version).
4) SDPIO Implementation Handbook, JPL D-16392, January 1999 (or latest version).
5) MISR Data System Science Requirements, JPL D-11398, September 1996 (or latest version).
6) MISR Level 1 Radiance Scaling and Conditioning Algorithm Theoretical Basis, JPL D-11507, Revision D, January 1999 (or latest version).
7) MISR Level 1 Georectification and Registration Algorithm Theoretical Basis, JPL D-11532, Revision B, August 1996 (or latest version).
8) MISR Level 1 In-flight Radiometric Calibration and Characterization Algorithm Theoretical Basis, JPL D-13398, June 1996 (or latest version).
9) MISR Level 1 Ancillary Geographic Product Algorithm Theoretical Basis, JPL D-13400, Revision B, March 1999 (or latest version).
10) MISR Science Data Quality Indicators, JPL D-13496, January 1997 (or latest version).
11) Data Production Software and Science Computing Facility (SCF) Standards and Guidelines, GSFC EOSDIS document 423-16-01
12) MISR Science Data Processing Quality Assessment Plan, JPL D-13965, 17 January 1997 (or latest version).

1.7 APPLICABLE DOCUMENTS

13) Science User's Guide and Operations Procedure Handbook for the ECS Project, HAIS 193-205-SE1-001 (or latest version).

14) Interface Requirements Document Between EOSDIS Core System (ECS) and Science Computing Facilities, HAIS 209-CD-005-005, March 1996 (or latest version).

15) Software Implementation Guidelines, JPL D-10622 (or latest version).

16) MISR Science Data System Error Policy, JPL D-13137 (or latest version).

17) Statement of Work for the Multi-Angle Imaging SpectroRadiometer (MISR), GSFC 421-12-13-03 (or latest version).

18) MISR Mission Operations Concepts and Requirements, JPL D-11594 (or latest version).

19) SDP Toolkit Users Guide for the ECS Project, HAIS 194-809-SD4-001 (or latest version).

2.0 INTERFACES

2.1 OVERVIEW

This section gives an overview of the external interfaces for Science Data Processing (SDP) for the AirMISR instrument. All AirMISR data processing takes place at the MISR SCF.

2.2 INPUTS/OUTPUTS FOR AirMISR PROCESSING

The inputs and outputs for the MISR SCF are listed below.

2.2.1 Inputs for the AirMISR Processing at the MISR SCF

Table 2-1: Input Ancillary Datasets and Products

Product	File Description
Ancillary Radiometric Product	AIRMISR_ARP_CONFIG_F02_001.hdf
	AIRMISR_ARP_INFLTCAL_T001_F02_001.hdf
	AIRMISR_ARP_PRFLTCAL_F02_001.hdf
	AIRMISR_ARP_PRFLTCHAR_F02_001.hdf
Camera Geometric Model	cal.camcol
	cal.orbmodel

2.2.2 Outputs for the AirMISR Processing at the MISR SCF

Table 2-2: Output Products

Product	File Description
Level 1B1 Radiometric Product	AIRMISR_RP_yymmdd_hhmmss_ca_Fvf_vc.hdf
Level 1B2 Georectified Radiance Product	AIRMISR_GP_yymmdd_hhmmss_ca_Fvf_vc.hdf

Where yymmdd corresponds to the date of the AirMISR flight, hhmmss is the approximate time of target overpass (UTC), ca is the camera angle identifier, vf is the file format version number and vc is the file content version number.

3.0 GENERAL FILE INFORMATION FOR AirMISR PRODUCTS

3.1 GENERAL FILE STRUCTURE

This document describes the specifications for the AirMISR products that will be archived at the NASA LaRC ASDC. The AirMISR files are implemented in the Hierarchical Data Format (HDF), except for the browse files which are in Graphical Interchange Format (GIF). Some of the HDF files covered by this document are of a special type: HDF-EOS Grid, which is an extension of the original HDF as developed by the National Center for Supercomputing Applications (NCSA). The HDF-EOS file interfaces were developed by the EOS Core System (ECS) developers. The standard NCSA HDF terminology as well as the EOS developed interface terminology are used in this document when describing these files.

The HDF-EOS data products created by AirMISR have been defined within the HDF framework and are supported by special application programming interfaces (API) which aid the data producer and user in applying the requisite conventions. These APIs allow data products to be created and manipulated in ways appropriate to each datatype, without regard to the actual HDF objects and conventions underlying them.

It is important to understand that the file specifications are given here are in terms of the logical implementation of the products in HDF and are not the physical description of file contents, although there is an attempt to show what the physical layout looks like. The same data object may exist in different relative locations for two iterations of a product file. The locations are determined by HDF on a file-by-file basis.

3.2 AirMISR PRODUCTS IN NATIVE HDF FORMAT

The AirMISR Ancillary Radiometric Product and the Level 1B1 Radiometric Product use the standard NCSA-supplied HDF file structure.

3.3 AirMISR PRODUCTS IN HDF-EOS GRID FORMAT

The HDF-EOS Grid is the implementation of HDF-EOS originally intended for storing Level 3 and above products, that is, products which have been "gridded" to a single Earth-based map projection. The storage of map projection parameters are part of the format, and routines to access the data in Grid format by geolocation are supplied in the Grid API.

The AirMISR Level 1B2 product includes a separate file for each camera angle at which data were acquired (typically 9 angles) during a single imaging run. As shown in Figure 1, a bounding box is first defined which encloses all of the images. The origin of the Universal Transverse Mercator (UTM) coordinate system associated with this run is then taken to be the upper left corner of the bounding box.

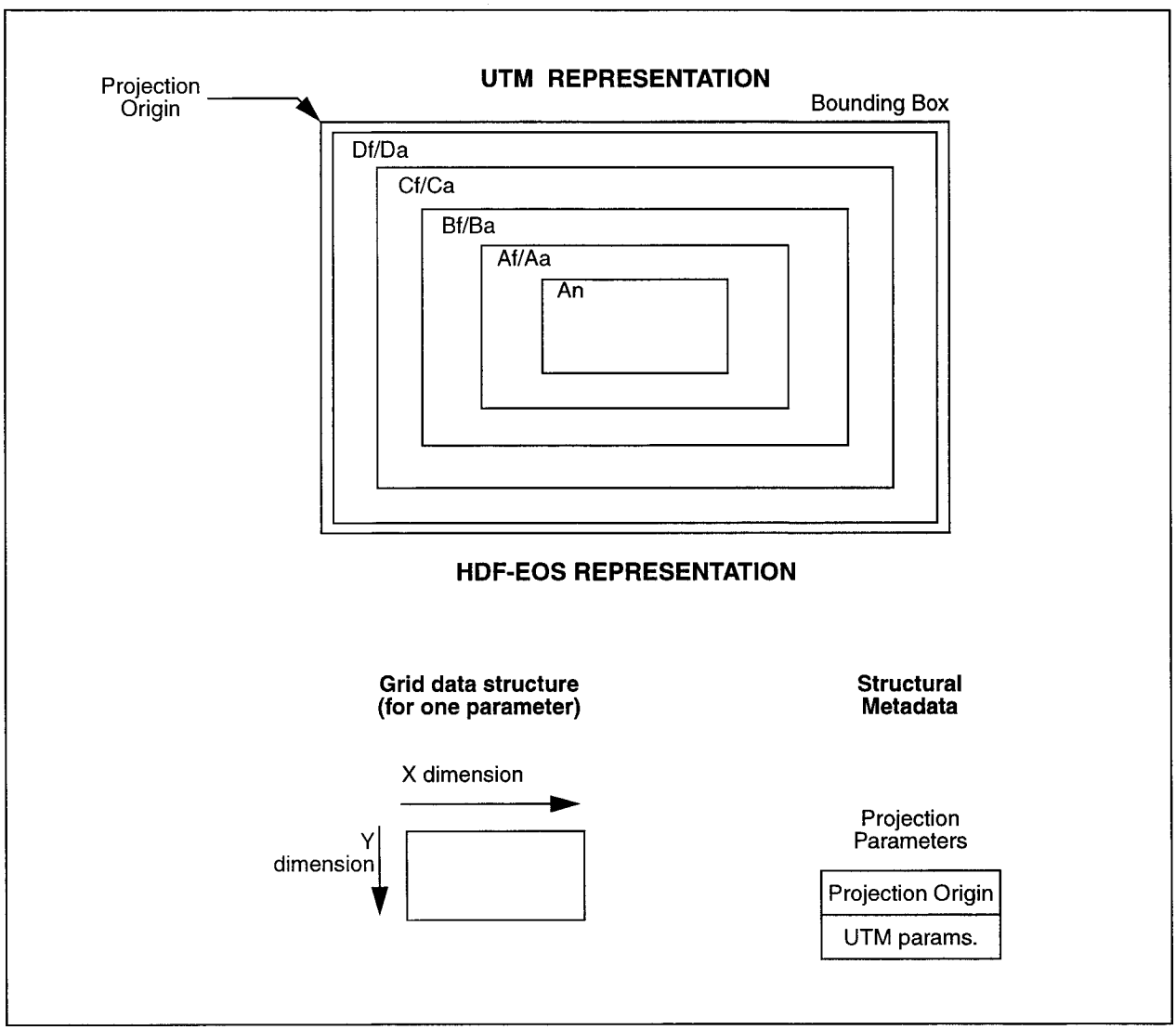

Figure 1: UTM Representation vs. HDF-EOS Grid Representation

3.4 AirMISR PRODUCT METADATA STORAGE

No matter what kind of product file is created, metadata must be attached to it for descriptive purposes

3.4.1 Level 1B1 Radiometric Product Metadata

Metadata for the Radiometric Product are stored in the native HDF file as File Metadata, SDS Metadata and Science Datasets, in some cases. A complete description of the parameters is given in Table 4-2.

3.4.2 Level 1B2 Georectified Radiance Product Metadata

Metadata for the Georectified Radiance Product is stored in the HDF-EOS Grid format file as Grid interface metadata. A complete description of the parameters is given in Table 5-3.

4.0 DATA PRODUCTS FOR LEVEL 1B1

4.1 RADIOMETRIC PRODUCT

4.1.1 Purpose

The Radiometric Product contains the radiances.

During radiance scaling and conditioning the DN values are converted to spectral radiances, and reported in MKS (meter, kilogram, second) units referred to as SI (Système International). Use is made of the camera calibration data, where the response of the system to a known radiance field is quantized. These data represent our best estimate of instrument response, as determined through many different activities.

It is noted that AirMISR does not provide a radiometric product scaled to the exo-atmospheric solar irradiance. As AirMISR does not view the Sun directly, such a data set could only be obtained by employing a solar model, and would be of no greater accuracy than the radiance product.

4.1.2 Product Description

The AirMISR Radiometric Product is produced in native HDF format. Each physical file contains the datasets shown in Table 4-1, including those with color designations corresponding to the four bands of the AirMISR camera.

Table 4-1: Level 1B1 Radiometric Product File and Datasets

Local Granule ID[a]	Dataset Name
AIRMISR_RP_yymmdd_hhmmss_ca_Fvf_vc.hdf	L1B1_Scaled_Rad_Blue
	L1B1_DQI_Blue
	L1B1_Scaled_Rad_Green
	L1B1_DQI_Green
	L1B1_Scaled_Rad_Red
	L1B1_DQI_Red
	L1B1_Scaled_Rad_Nir
	L1B1_DQI_Nir
	line_summary
	std_total_resp
	rad_gain_coeff_1x1
	integration_time

a. Where yymmdd corresponds to the date of the AirMISR flight, hhmmss is the approximate time of target overpass (UTC), ca is the camera angle identifier, vf is the file format version number and vc is the file content version number.

4.1.3 Radiometric Product Files

Table 4-2: AirMISR Level 1B1 Radiometric Product File Contents

Parameter name, symbol, and units	Description	No. of values	Origin	HDF file structure name
Science Data Sets				
Scaled Radiance, $L^{std}(l_{ccd},p)$.	Total-band, standardized spectral response function weighted.	l_{ccd} x 1504		L1B1_Scaled_Blue L1B1_Scaled_Green L1B1_Scaled_Red L1B1_Scaled_Nir
Image data quality indicator, IDQI (l_{ccd},p)	0 (within specification), 1 (reduced accuracy), 2 (unusable for science), or 3 (unusable for any purpose). Reports performance due to saturation, SNR, or loss of data. See footnote [a].	l_{ccd} x 1504		L1B1_DQI_Blue L1B1_DQI_Green L1B1_DQI_Red L1B1_DQI_Nir
Per line report: 1) navigation data loss; 2) lost line; 3) corrupt line; 4) pixel 1-1504 DN average, standard deviation, minimum, maximum; 5) overclock pixels 1513-1520 DN average and standard deviation. Note: items 1-3 can be flaged with a 0/1 bit.		l_{ccd} x 7		line_summary
Radiance calibration coefficients, $G_0(p,b)$ [DN], $G_1(b,p)$ [DN/ W m^{-2} μm^{-1} sr^{-1}], $G_2(b,p)$ [DN/ (W m^{-2} μm^{-1} $sr^{-1})^2$]		3x1504x4	AM-ARP	rad_gain_coeff_1x1
$t_{integ}(b)$ [msec]	Integration time associated with above calibration coefficients	4	AM-ARP	integration_time

Table 4-2: AirMISR Level 1B1 Radiometric Product File Contents (Continued)

Parameter name, symbol, and units	Description	No. of values	Origin	HDF file structure name
$S_\lambda(b,\lambda)$ [none], standardized response profiles		4x1471	AM-ARP	std_total_resp
File Metadata				
Site location name		1		site_name
Experiment date [yyyymmdd]	This is the date corresponding to the UT time stamp of the first image line, i.e.19980625	1		exp_date
Expected overpass time [UT]		1		expected_overpass_time
Intended target coordinates: latitude [±ddd.ddddd]	Center of target	1		intended_target_lat
Intended target coordinates: longtitude [±ddd.ddddd]	Center of target	1		intended_target_lon
Local time zone name	It is possible for the image to be acquired over an area which spans two time zones. We define the time zone as that associated with the first image line.	1		time_zone_name
Time difference Local time-UT, Δt [hh]		1		ut_to_local_time
Earth-Sun distance (A.U.)		1		earth_sun_distance

Table 4-2: AirMISR Level 1B1 Radiometric Product File Contents (Continued)

Parameter name, symbol, and units	Description	No. of values	Origin	HDF file structure name
Camera serial no. or identifier		1		serial_number
View angle [±dd.d]	Nominal camera gimbal pointing angle	1		camera_angle
Band names (e.g., Band 1/ Blue)		4		band_name
UT time of first image line [hh.ddddd]		1		time_start
UT time of last image line [hh.ddddd]	Ground target assumed to be in time zone where first image line was acquired.	1		time_stop
Number of image lines, l_{ccd}	Identical for all four bands.	1		no_lines
File revision number	Incremented if this L1B1 file updates and replaces a previous delivery	1		file_revision_number
File generation code name	Code which reads raw image and navigation, and AM-ARP data and writes L1B1 file.	1		code_name
Generation code configuration label	Traces production code configuration used to write the output file	1		code_cm_label

Table 4-2: AirMISR Level 1B1 Radiometric Product File Contents (Continued)

Parameter name, symbol, and units	Description	No. of values	Origin	HDF file structure name
Per view-angle report: 1) Angle reached or missed report; 2) % of lost lines (per band); 3) % of interpolated lines (per band) 4) % of saturated pixels (per band) 5) % of navigation data acquired		6		angle_reached lost_line_pct_blue lost_line_pct_green lost_line_pct_red lost_line_pct_nir interp_line_pct_nir interp_line_pct_blue interp_line_pct_green interp_line_pct_red sat_pixel_pct_nir sat_pixel_pct_blue sat_pixel_pct_green sat_pixel_pct_red nav_data_pct
SDS Metadata				
Radiance scaling factor [1/(W m^{-2} μm^{-1} sr^{-1})]		4		Rad_scale_factor
Integration time [msec]		4		Ccd_int_time
$E_0^{std,in\text{-}band}$ [W m^{-2} μm^{-1}]	Solar irradiances, in-band standardized response weighted	4	AM-ARP	std_inband_solar_wgted_height
$\lambda_{m,solar}^{std,in\text{-}band}$ [nm]	Center wavelength, solar and in-band standardized response weighted	4	AM-ARP	std_inband_solar_wgted_center_wav
$\Delta\lambda_{m,solar}^{std,in\text{-}band}$ [nm]	Bandwidth, solar and in-band standardized response weighted	4	AM-ARP	std_inband_solar_wgted_width

Table 4-2: AirMISR Level 1B1 Radiometric Product File Contents (Continued)

Parameter name, symbol, and units	Description	No. of values	Origin	HDF file structure name
E_0^{std} [W m^{-2} μm^{-1}]	Solar irradiances, standardized response weighted	4	AM-ARP	std_solar_wgted_height
$\lambda_{m,solar}^{std}$[nm]	Center wavelength, solar and standardized response weighted	4	AM-ARP	std_solar_wgted_center_wav
$\Delta\lambda_{m,solar}^{std}$ [nm]	Bandwidth, solar and standardized response weighted	4	AM-ARP	std_solar_wgted_width
L_{max}(b) [W m^{-2} μm^{-1} sr^{-1}]	Band weighted maximum radiance	4	AM-ARP	band_wgted_max_rad

a. IDQIs correspond roughly to a <3%, 3-5%, 5-10%, and >10% absolute radiometric error
b. AM-ARP is AirMISR Ancillary Radiometric Product

5.0 DATA PRODUCTS FOR LEVEL 1B2

5.1 GEORECTIFIED RADIANCE PRODUCT

5.1.1 Purpose

The Level 1B2 Georectified Radiance Product (GRP) consists of four parameter sets that have had applied certain kinds of geometric correction and have been projected to a Universal Transverse Mercator (UTM) map grid. First, the terrain-projected TOA radiance parameter has had a geometric correction applied which removes the errors of aircraft position and pointing knowledge and errors due to topography. The parameter is then ortho-rectified on a reference ellipsoid at the surface. Second, the ellipsoid-projected TOA radiance parameter uses supplied aircraft position and pointing and is not corrected for topography, but is resampled to the reference ellipsoid. Third, there are the geometric parameters which measure the sun and view angles at the reference ellipsoid. The parameters defined here also carry a Radiometric Data Quality Indicator (RDQI) associated with the parameter.

5.1.2 Product Description

The product is produced as single physical file, as shown in Table 5-1. Each physical file is in the HDF-EOS Grid format and each contains one or more HDF-EOS Grid datasets, corresponding to parameters at certain spatial resolutions. The grid datasets will have the usual x and y dimensions. The x and y dimensions will correspond to the the number of samples in the along-track and cross-track directions.

Table 5-1: Level 1B2 Georectified Radiance Product File and Datasets

Local Granule ID[a]	Dataset Name
AIRMISR_GP_yymmdd_hhmmss_ca_Fvf_vc.hdf	Terrain Blue
	Terrain Green
	Terrain Red
	Terrain Infrared
	Terrain Blue DQI
	Terrain Green DQI
	Terrain Red DQI
	Terrain Infrared DQI
	Ellipsoid Blue
	Ellipsoid Green
	Ellipsoid Red
	Ellipsoid Infrared
	Ellipsoid Blue DQI
	Ellipsoid Green DQI
	Ellipsoid Red DQI
	Ellipsoid Infrared DQI
	Sun Azimuth (degrees)
	Sun Zenith (degrees)
	View Azimuth (degrees)
	View Zenith (degrees)

a. Where yymmdd corresponds to the date of the AirMISR flight, hhmmss is the approximate time of target overpass (UTC), ca is the camera angle identifier, vf is the file format version number and vc is the file content version number.

5.1.3 Georectified Radiance Product Files

Table 5-2: AirMISR-Grid data structures

Parameter name	Description	Dimensions	Format	HDF metadata name(s)
location, upper left corner [UTM coordinates]		2 values	float (f12.5)	location, upper left corner
location, lower right corner [UTM coordinates]		2 values	float (f12.5)	location, lower right corner
Scaled radiance, I_{utm}_band_terr(l_{utm},s) [unitless].	Total-band, standardized spectral response function weighted, resampled to UTM grid (terrain projected).	XDim, YDim	uint16	Terrain Blue, Terrain Green Terrain Red Terrain Infrared.
Data quality index, DQI_band_terr	Value=0 if data missing in some of the 9 image files; Value=255 if data good (Isn't this backwards to the MISR convention of 0=good; 255=bad)	XDim, YDim	uint8	Terrain Blue DQI, Terrain Green DQI Terrain Red DQI Terrain Infrared DQI.
Scaled radiance, I_{utm}_band_ellip(l_{utm},s) [unitless].	Total-band, standardized spectral response function weighted, resampled to UTM grid (ellipsoid projected).	XDim, YDim	uint16	Ellipsoid Blue, Ellipsoid Green Ellipsoid Red Ellipsoid Infrared.
Data quality index, DQI_band_ellip	Value=0 if data missing in some of the 9 image files; Value=255 if data good (Isn't this backwards to the MISR convention of 0=good; 255=bad)	XDim, YDim	uint8	Ellipsoid Blue DQI, Ellipsoid Green DQI Ellipsoid Red DQI Ellipsoid Infrared DQI.

Table 5-2: AirMISR-Grid data structures (Continued)

Parameter name	Description	Dimensions	Format	HDF metadata name(s)
Solar zenith angle $\theta_o(l_{utm},s)$ [degrees]		XDim, YDim	float32	Sun Azimuth (degrees)
Solar azimuth angle $\phi_o(l_{utm},s)$ [degrees]		XDim, YDim	float32	Sun Zenith (degrees)
View zenith angle $\theta(l_{utm},s)$ [degrees]		XDim, YDim	float32	View Azimuth (degrees)
View azimuth angle $\phi_o(l_{utm},s)$ [degrees]		XDim, YDim	float32	View Zenith (degrees)

Table 5-3: AirMISR-Metadata (attributes) display

Parameter name	Description	Dimensions	Format	HDF metadata name(s)
location, upper left corner [lat, lon]		2 values	float64	UL Corner (deg): Latitude Longitude
location, lower right corner [lat, lon]		2 values	float64	LR Corner (deg): Latitude Longitude
Radiance scale factor, $L_{utm}(b,l_{utm},s)$ [W m^{-2} sr^{-1} μm^{-1}].		XDim, YDim	float64	Rad_scale_factor (1=Blue;2=Green;3=Red ;4=Nir)
$E_0^{std}(b)$ [W m^{-2} μm^{-1}]	Solar irradiances, standardized response weighted	XDim, YDim	float64	(std_inband_solar_wgted _height) (Values 1-4)

Table 5-3: AirMISR-Metadata (attributes) display (Continued)

Parameter name	Description	Dimensions	Format	HDF metadata name(s)
$\lambda_{m,solar}^{std,in\text{-}band}$ [nm]	Center wavelength, solar and in-band standardized response weighted	4	float64	std_inband_solar_wgted _center_wav
$\Delta\lambda_{m,solar}^{std,in\text{-}band}$ [nm]	Bandwidth, solar and in-band standardized response weighted	4	float64	std_inband_solar_wgted _width
E_0^{std} [W m^{-2} μm^{-1}]	Solar irradiances, standardized response weighted	4	float64	std_solar_wgted_height
$\lambda_{m,solar}^{std}$[nm]	Center wavelength, solar and standardized response weighted	4	float64	std_solar_wgted_center_ wav
$\Delta\lambda_{m,solar}^{std}$ [nm]	Bandwidth, solar and standardized response weighted	4	float64	std_solar_wgted_width
L_{max}(b) [W m^{-2} μm^{-1} sr^{-1}]	Band weighted maximum radiance	4	float64	band_wgted_max_rad
Start image time (UT)		scalar	char8	Minimum_image_time
End image time (UT)		scalar	char8	Maximum_image_time
Earth-Sun distance (A.U.)		scalar	float64	Sun_distance